Development of a Calibrated Watershed Model, Potomac River Basin

A Cooperative Project between the U.S. Geological Survey (USGS),
the Interstate Commission on the Potomac River Basin (ICPRB),
the Maryland Department of the Environment (MDE), and the
U.S. Environmental Protection Agency Chesapeake Bay Program Office (CBP)

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Project Description

Problem. Work performed by the National Water-Quality Assessment (NAWQA) Program Potomac River Basin study unit (1992-95) indicated that elevated concentrations of nutrients in surface and ground water in the basin often result from human activities such as manure and fertilizer application. A watershed model of the basin is needed to assess the effects of point and nonpoint nutrient and sediment sources on water quality in the Potomac River and its tributaries.

Objectives. The USGS is responsible for the following objectives: 1) compile necessary data for simulation of Potomac watershed processes, using the Hydrologic Simulation Program-FORTRAN (HSPF); 2) create necessary control files for HSPF simulation of the Potomac River Basin, following the framework developed by CBP for Phase 5 of the Chesapeake Bay Watershed Model (CBWM); 3) develop and implement innovative calibration procedures to improve HSPF model calibration; 4) calibrate an HSPF model for the Potomac River Basin; and 5) prepare reports on calibration and analysis of model results.

Benefits and relevance. The calibrated Potomac Watershed Model will allow resource managers to simulate the effects of land-use changes and best management practices on water quality and evaluate alternative approaches for correcting existing water-quality and water-quantity problems within the Potomac River Basin. The proposed study also meets several goals of the USGS Water Resources Division (WRD).

Approach and methods. The proposed study will involve the following tasks: 1) compilation of existing input data, development of model segmentation and network, processing of time-series data, and compilation of ancillary data and observational data for model calibration; 2) development of a model calibration strategy through implementation of existing software for general inversion and calibration of multi-parameter hydrological models; 3) calibration of hydrological and water-quality model (sediment and nutrients); 4) analysis of model results, including consideration of specific study questions; and 5) dissemination of calibrated model and preparation of final reports analyzing the model results.

Progress During Reporting Period

During the past 3 months, the following tasks were completed by the USGS:

1. F-tables were completed by Doug Moyer, USGS, Richmond.

2. Modifications to segmentation, including minor corrections and inclusion of reservoirs, were made by Sarah Martucci (USGS, Baltimore), Jennifer Krstolic and Alan Simpson (USGS, Richmond, and Kate Hopkins (CBP).

3. Significant testing of the External Transfer Model (ETM), developed by Gary Shenk (CBP), was performed and initial trial model runs for the Patuxent River Basin were made.

4. A number of files necessary for modeling were created, expanded, or modified. This includes land segment names, river reach names, and specification of connections between land segments and reach watersheds.

Completion of F-tables (Doug Moyer, USGS, Richmond)
Regional regression of cross-sectional data was completed, allowing prediction of stream geomorphologic parameters for reaches without USGS stream-gaging stations. F-tables were created for the non-reservoir reaches, and for reaches with and without USGS stream-gaging stations, using the program XSECT. Rating curves for gages were used to correct the streamflow values in the F-tables, and a regionalization of this correction, which resulted in adjustment of Manning's roughness coefficient, was performed.

Modifications to Segmentation
A number of final corrections and adjustments were made, including addition of qualifiers for reaches with a reservoir. Significant quality assurance of the coverage was performed by Jennifer Krstolic and Ala Simpson (USGS, Richmond). Data tables associated with the overages were updated, which allowed for the creation of a number of necessary model files (see below).

Testing of External Transfer Module (ETM)
The ETM is code that allows land simulation results to be written to WDMs and accessed for input to reaches, based on the overlap of land segments and reach watersheds. This software is newly developed by Gary Shenk and underwent significant testing and upgrading over the first quarter of the year. A complete simulation of the Patuxent was accomplished, although with incorrect land use and parameters.

Development of Model Files
Based on the revised model segmentation, a number of files were created that are necessary for model development, including lists of land segment names, river reach names, and the connections between and segments and reach watersheds. A MATLAB-based pre-processor was developed by Joe Vrabel (USGS, Baltimore) that allows the modeler to generate the necessary segment lists for running a portion of the model, by major basin, minor basin, or reach (CATCODE).

Plans for Next Quarter

1. Create F-tables for reservoirs.

2. Draft segmentation report.

3. Complete precipitation modeling and generate WDM files for hourly precipitation, temperature, and potential evapotranspiration, using the Hamon (1961) method.

4. Investigate the use of hydrograph separation and recession analyses for the initial estimates for certain model parameters.

5. Complete initial version of MATLAB-based post-processor for hydrology calibration.

6. Assemble all files, including 2000 land use and initial parameter estimates, for a run of the model for the Potomac River Basin.